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AGRICULTURAL NEWS LETTER

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This publication gives information on new developments of interest to agriculture on laboratory and field investigations of the du Pont Company and its subsidiary companies.

In addition to reporting results of the investigations of the Company and its subsidiaries, published reports and direct contributions of investigators of agricultural experiment stations and other institutions are given dealing with the Company's products and other subjects of agricultural interest.

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Agricultural News Letter,
E. I. du Pont de Nemours & Company,
Wilmington, Del.

WHITE ARSENATES FOR AGRICULTURAL INSECTICIDES TO BE COLORED PINK TO IDENTIFY THEM AS POISONS

With a view to preventing possible cases of poisoning, white arsenates -- such as lead arsenate and calcium arsenate -- which are universally used as agricultural insecticides will be given a distinctive pink color, under a voluntary agreement of the producers of these chemicals, it is announced at the offices of the Manufacturing Chemists Association, Washington, D. C.

This safety measure has been adopted after a five-year study and extensive tests to observe the results, which indicate that the change of color should provide a satisfactory safeguard against white arsenates being mistaken for materials for household or other uses.

Lead arsenate now being produced for the 1938 crop season is colored pink, while the color of calcium arsenate will also be changed from white to pink when present stocks of the insecticide are exhausted.

The United States Public Health Service, and medical and agricultural authorities commend the action of the manufacturers of agricultural arsenates.

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A NEW ENGINEERING MATERIAL WITH VARIOUS POSSIBILITIES FOR USE IN THE AGRICULTURAL FIELD OFFERED IN NEOPRENE

EDITOR'S NOTE:- In common with those in other lines, engineers and designers of agricultural equipment are at times hampered in their work by lack of suitable materials. It is to give information which may be useful in choosing from among natural rubber and "synthetic rubbers," when rubber-like properties are required, that this article has been prepared. Further information will be supplied on request.

By A. F. Clark,
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Practically every problem of product development hinges on or is affected by the choice of the material or materials to be used. To complicate the situation, the development of suitable materials usually lags behind the need. In the early history of industrial development many really outstanding inventions were stopped completely because of the lack of a suitable material. For example, James Watt was forced to postpone development of his steam engine for years because of lack of materials adapted to the purpose.

Today, the machine or product designer is not ordinarily hampered as were his predecessors. However, these designers frequently develop products or machine parts that should be made of a material having a combination of properties not available in any existing material, so a more or less unsatisfactory substitution is made. This situation is most frequently encountered when the material for the required purpose should have the strength, abrasion resistance, resilience and elasticity of rubber, yet must be exposed to heat, oils, sunlight, ozone or chemicals--all factors which materially shorten the life of rubber.

The definite need for a material with rubber's properties, yet one which would not be attacked by the many enemies of rubber has resulted in extensive research extending over a great many years. Literally thousands of chemists have tried to duplicate rubber artificially, but such a duplication would not answer the problem, as such an artificial or synthetic rubber would still be subject to attack by the various deteriorating influences. Dr. Wolfgang Ostwald, famed colloidal chemist, was one of the first to point out the error of the artificial rubber approach. In 1913 he said, "It seems to me that interest in artificial rubber does not today center in the possibility of finding a substitute for the natural product, but more in the possibility of making a decidedly better one. By the synthesis of a 'noble rubber,' materials might be produced which would not only show properties superior to the ordinary natural article, but of a marketable character."

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Thinking along the same lines, chemists of E. I. du Pont de Nemours & Co., Inc., set as their goal the development of a material that could be used in applications where rubber-like properties were required, but, in addition, a material that would resist the deteriorating effects of the various substances it might contact. They did not try to duplicate natural rubber, as had others, but set as their task the development of a new product better adapted than rubber to present-day industrial needs.

A New Engineering Material

The result of this development work was neoprene, an entirely new engineering material that fits into no existing classification. It has many of the physical properties of rubber, yet it cannot be properly called synthetic rubber because it is different in chemical composition. Neither can it be called a rubber substitute since it costs more than rubber and has physical properties which make it superior to rubber for use under severe service conditions. Chemically, it is polymerized chloroprene, and physically, it is a rubber-like material having unique properties.

Neoprene is made from coal, limestone, salt, and water. Coal in the form of coke, and lime (from limestone) produce calcium carbide. Calcium carbide with water makes acetylene. Acetylene gas was converted to divinylacetylene in the du Pont Laboratories by a catalytic process invented by the late Dr. J. A. Nieuwland of Notre Dame University. Attempts to convert divinylacetylene into synthetic rubber resulted in failure. But members of the du Pont research staff later found that Dr. Nieuwland's process could be modified to produce monovinylacetylene, and further discovered that the treatment of monovinylacetylene with hydrogen chloride (obtained from salt) resulted in a previously unknown chemical which was called chloroprene. Their next discovery was that chloroprene could be converted by polymerization to a rubber-like solid superior to natural rubber in many respects.

The name neoprene was adopted for this material to provide a generic term which could be used not only to designate du Pont's chloroprene rubber, but also to describe the thousands of products made from it by rubber manufacturers.

Neoprene is sold by du Pont to rubber manufacturers who make it into hose, belting, gasket material, molded, and other finished products.

It is protected by patents, but is sold without restriction to any competent manufacturer who has equipment for mixing, forming, and vulcanizing rubber.

Compounded Like Rubber

Like rubber, neoprene is mixed with reinforcing pigments, fillers, and organic compounds to impart to the finished product those properties desired for specific service conditions. These compounds are shaped for vulcanization on the same equipment used for rubber, and are vulcanized to convert them into the tough, elastic products used in industry. By varying the kind and amount of compounding ingredients, different properties can be secured in the finished

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product. All articles made of neoprene possess the strength, resilience, abrasion resistance and elasticity of some rubber, and in addition, resist the deteriorating effects of oils, heat, sunlight, chemicals, ozone, and aging.

It is important to remember that the usefulness of a neoprene compound depends on its composition and the skill of the rubber manufacturer making it as well as on the inherent superiority of the base material--neoprene.

Practically all rubber manufacturers are today producing a wide variety of products made from neoprene. Cements, obtained by dissolving neoprene in a solvent, are also available.

Neoprene is also available in latex form. This product consists of colloidal particles of neoprene suspended in water. Neoprene latex is used for impregnating porous materials or may be deposited as a film on a smooth surface. In either case evaporation of the water leaves a deposit of partially vulcanized neoprene which on further heating has physical and chemical properties similar to compositions made from dry neoprene.

Important Properties of Neoprene

The primary advantage in the use of a neoprene compound is that products made from this material give considerably more service under severe conditions than do similar rubber compounds. Neoprene combats many of the natural enemies of rubber. For example, even at normal temperatures, natural rubber deteriorates due to oxidation. In recent years, materials known as anti-oxidants have been used in rubber compounds for the purpose of retarding this action, but, in spite of this, oxidation of rubber is still a serious problem. Neoprene compounds are many times more resistant to oxidation than even the best modern rubber compounds.

Direct sunlight is one of the worst enemies of rubber. The effect known as "sun checking" is observable in many products such as garden hose and automobile tire side walls. Neoprene products are practically unaffected by sunlight, the only change being a slight stiffening upon prolonged exposure.

All neoprene compounds display a marked superiority to like compounds of rubber with respect to heat resistance, but best results are obtained by the use of special compounds. These compounds show the greatest superiority at temperatures between 180°F and 300°F. The fundamental difference in the effect of elevated temperatures on rubber and neoprene is that vulcanized neoprene compounds never undergo reversion (softening and weakening) such as occurs to the best heat resisting rubber. Instead, neoprene gradually hardens when exposed to elevated temperatures.

Neoprene resists to a remarkable extent deterioration by most chemicals. However, in many cases, a special compound should be used for a given type of chemical. Because of this, a small-scale test is often advisable before making an extensive installation.

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When ordinary rubber is exposed to oils it becomes swollen, and its tensile strength, toughness, elasticity and abrasion resistance are materially reduced. Neoprene also swells from contact with oils, but to a much less extent, and --what is of greater importance-- it retains its strength, toughness, elasticity and abrasion resistance to a remarkable degree even when swollen. Rubber can be compounded to increase its oil resistance, but neoprene compounds are vastly superior to even the best so-called "oil resisting" rubber.

The heavier fractions of refined crude oil have less effect on neoprene than the lighter ones. For example, lubricating oil deteriorates neoprene at a slower rate than does kerosene or gasoline. Neoprene compounds in contact with animal fats, fish oils, and most vegetable oils, also display superior resistance.

Suggested Uses in Agricultural Lines

As will be understood from the summary of the properties of neoprene, the major field of application in agricultural lines is in farm machinery and equipment. As a summary of the variety of products that can be made from neoprene, it might be well to note the following:

Neoprene jacketed portable cord is widely used for lamp and portable tool cords. Neoprene jacketed ignition cable is superior to other types especially in motors that run hot. The heat and oil resistance of neoprene also accounts for the wide acceptance of neoprene for motor leads. Many other types of high capacity power cable are jacketed with neoprene because it does not support combustion and resists sunlight.

Neoprene lined hose is indispensable in the transportation and distribution of oil and gasoline. Many types of neoprene oil hose are made, such as automobile service station or gasoline pump hose, oil suction and discharge hose, and fuel oil hose. Neoprene hose may also be used for handling other materials which deteriorate rubber, such as oil emulsions, fuel gases and chemicals.

An especially important field for neoprene compounds is in the production of gaskets. Gaskets or sealing rings must be resilient so that they will not flow out and lose the seal. They also must resist the action of heat, gases and liquids which come in contact with them. No other material has both the resilience and the resistance to deterioration which neoprene possesses. Neoprene sheets provide ideal gasketing for severe service conditions. In this form, neoprene is available in thicknesses from 1/32 to 1/2 inch and more. Asbestos sheet packing with neoprene binder is used where a hard packing is required to withstand exceedingly high temperatures. Cork bound neoprene gasket material is strong and flexible and resists deterioration. Such a sheet is rapidly replacing the fragile cork sheet with which everyone is familiar. Molded gaskets and seals are being supplied by practically all rubber manufacturers to specifications.

Diaphragms made from neoprene compositions are less permeable to gases and liquids than rubber and are particularly suitable for use under severe service

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conditions. They may be cut from neoprene sheeting manufactured either with or without fabric insertion, or they may be molded by rubber manufacturers having suitable mold equipment. Neoprene diaphragms are used in automatic switches, fuel pumps, gas regulators, flow valves, etc.

In addition to these machinery applications, neoprene compounds provide auxiliary equipment for the laboratory, dairy, or other semi-agricultural use. For example:

The ability of neoprene to resist the deterioration caused by chemicals makes it a valuable material in the manufacture of aprons for workmen or chemists who come in contact with oils, fats or chemicals. The manufacturers of these aprons have made them available in a wide variety of styles.

Neoprene covered canvas work gloves are comfortable to wear, are unaffected by oil and greases, and are exceptionally long lived in rough service conditions. Neoprene gloves without canvas backing are used to protect the hands of the workmen against animal fats, acids, solvents, and corrosive chemicals.

Fabrics coated with neoprene are used for heavy duty raincoats and jackets worn by workmen requiring a sun-proof, oil-resistant and waterproof garment that is also strong and comfortable. Sheetings, ducks, silk or other fabrics may be impregnated with neoprene. Such fabrics are valuable in the manufacture of tenting, tarpaulins, upholstery and protective coverings.

The experiences of processors and users of various products shows that neoprene is the most satisfactory material for a great many applications. Its truly remarkable properties fit it for use under extremely severe conditions. In addition, it has all of the fundamental properties of rubber, such as the strength, resilience, abrasion resistance and elasticity, so necessary in countless uses.

Although all products containing neoprene cost more than similar articles of rubber, the increased cost is often insignificant when considered in relation to the savings effected by lowered operating and replacement costs.

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PORTABLE SEED CLEANING AND TREATING EQUIPMENT FOUND USEFUL FOR PREPARING SEEDS FOR PLANTING

EDITOR'S NOTE:- The description of portable seed cleaning and treating equipment and discussion of its advantages, given below, are from Circular No. 230, Purdue University Agricultural Experiment Station, Lafayette, Indiana. This circular was written by Mr. C. E. Skiver.

The proper cleaning and treating of such bulky field seeds as wheat, oats, and soybeans has of late presented a real problem in Indiana and similar corn belt sections. The rapid increase of weeds, the seeds of which are difficult to separate from the grains, such as Corn Cockle in wheat and Morning Glories in soybeans, and the spasmodic outbreaks of the various diseases, such as smuts of the small grains, present serious problems.

The rapid change to the "combine harvester" in the corn belt area further increases the need for effective seed cleaning, as most of the weed seeds are put back on the fields.

The seed cleaning equipment available to the Indiana farmer is a small farm type fanning mill of his own or the receiving separator of the near-by elevator. The average farm type fanning mill has no brushes or other equipment to keep the screens open and its air blast is seldom strong enough to make the proper gravity separations of the heavier field seeds. The separation made by the fanning mill is dependent upon two factors, specific gravity and size. The foreign material lighter than the seeds is blown out by the air blast, while those particles of the same specific gravity, yet smaller than the seeds, are removed by the bottom screen. When the power is wanting, as it often is on the hand mill, the specific gravity separation is poor, as is the sizing separation when the lower screen is not kept open. The small mill, therefore, is hardly adequate to properly clean the bulky field seeds. The receiving separators in the country elevators are regulated for the cleaning of commercial grain stocks and do not clean close enough to make the difficult separations that are necessary for the proper preparation of seed. Another danger of the commercial elevator is the contamination of the seed with other grains and weeds, as it is almost impossible to properly clean all the grain channels.

Very few or no mechanical treating devices are available for applying the dust treatment for smut to wheat, oats, or barley. Where the hand or shovel mixing method is necessary, the seed treatment is often omitted due to the tedious nature of the operation and the irritating effect of the disinfectant dusts.

The portable seed cleaning and the treating unit which travels from farm to farm and cleans or treats the seed, offers an excellent solution to the problem when properly handled. The portable equipment has the following advantages:

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1. It provides the services of improved cleaning and treating equipment, such as the large type fanning mill with traveling brushes, the disc separator, and the automatic treater that most farmers cannot afford to own.

2. It is more economical to transport the equipment to the grain than it is to bring the grain into a central point (stationary cleaner).

3. It saves labor by making all operations, such as weighing and sacking, automatic.

4. The portable feature enables the equipment to be utilized for a long period each season, thus warranting the investment.

Construction and Equipment Used

The portable unit is constructed on a special truck body of its own so that it can be easily mounted or removed from a truck chassis. This permits the truck to be released for other duties during periods when the cleaner is not in operation. The special body is built to fit any truck chassis of the standard makes of trucks on the market today. It can be mounted on the short wheelbase (137 inches) or the long wheelbase (157 inches). While it works well on either length there seems to be less vibration on the long wheelbase dual wheel truck.

The over-all height of the unit when mounted is 8 feet 7 inches, the length 11 feet, and the width 6 feet. The compactness and mobility of this assembly enable it to be placed in driveways or sheds near the grain storage place, thus saving much time and labor in the handling of the grain before and after cleaning.

The receiving hopper is located on the right side of the assembly. It has a capacity of one to one and one-half bushels. Just below this is the automatic grain register which discharges into a drag line that carries the grain up to a short auger. This auger delivers it to the fanning mill.

The Fanning Mill

The type of mill found best adapted to the cleaning of field seeds as well as to the portable assembly is a two-screen separation, under-shot air blast mill. The screen surface of the mill used is 34 inches wide and 42 inches long, which provides a rated capacity of over twice the maximum rate at which the grain goes over the unit. This insures a good job of cleaning on the part of the essential unit.

Power driven traveling brushes serve to keep the screens open at all times. This is a very important feature, particularly on the bottom screen, for, without this mechanism, it soon becomes stopped up and the sizing function of the mill is practically lost. Sufficient air blast to make the gravity separation should be provided at all times.

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Disc Separator

The disc separator makes such difficult separations as Corn Cockle from wheat. The discs for these machines are furnished in various sizes and the machine should be equipped with the proper sizes of discs for the separation to be made. The efficiency of the disc separator depends largely upon having the proper discs, maintaining the proper speed at all times and avoiding vibrations as much as possible. Discs with slightly larger cups are used for seed cleaning than for commercial grain stocks, as better separations are desired and heavier tares are not as objectionable.

When cleaning grains where disc separations are not necessary, an attachment is made to shunt the grain around the cockle machine, using only the fanning mill and the treater.

The Seed Treater

The seed treater consists of a rotating drum through which the seed passes in a continuous stream and a mechanical driven dust feeder that feeds the disinfectant into the grain line as it enters the mixing drum. The mixing drum rotates at 50 R.P.M. and has metal flanges on the inside which not only mix the grain with the disinfectant dust but pick it up and drop it through air that is saturated with dust particles. The grain is discharged from the lower end of the mixing drum into a sacker. The mechanical dust feeder is the all-important part of the seed treater. This feeder must be accurate and readily adjustable to discharge the proper amount of disinfectant dust into the grain stream, which varies in size from job to job and when different grains are being treated. The dust mechanism should be designed to handle copper carbonate which is applied at the rate of two ounces per bushel or the mercury compounds which are applied as low as one-half ounce per bushel.

The Power Unit

A 3-5 horse power gasoline engine is used to furnish power for the unit. The high speed type of engine with plenty of power has proven most desirable as it causes less vibration of the frame and thus permits better separations by the cleaning units. As the engine has to run in dusty air most of the time, the covered crank case with splash oil feed system is a decided advantage. The use of good power equipment cannot be overemphasized, for nothing causes more delay than a faulty engine.

Capacity

The capacity of the portable seed cleaner and treater ranges from 40 to 60 bushels per hour, depending upon the condition of the seed to be cleaned. If there are difficult separations to be made, the rate will be low, while if the grain is good it will go through faster. The machines will average around 50 bushels per hour, which is about as fast as the attendants can get the grain to the machine and the cleaned seed away.

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Operation of Machine

The machine is usually set with the receiving hopper at the granary door to avoid all the carrying possible. Leveling the machine from side to side is very important as it assures the use of the entire screen surface of the fanning mill. If one side is slightly lower than the other the grain will not be evenly distributed over the screens nor through the air blast. The machine should not be set where the fan has to blow into a heavy wind, as it decreases the efficiency of the air blast unless the machine has sufficient adjustment to offset this handicap.

The rate at which the grain goes over the cleaner and the proper adjustments of the cleaning units are very essential to good results. The rate of cleaning is regulated by a slide in the bottom of the receiving hopper.

The selection of the size and type of screens to be used in the fanning mill is very important and varies with the type of separation to be made. The following are the screens commonly used.

Wheat:
- Upper--round perforations, 14/64 inches.
- Lower, for cockle--round perforation, 8/64 inches.
- Lower, for cockle and cheat--slotted perforation, 1/12 x ½ inch.

Oats:
- Upper--slotted perforations, 14/64 x ¾ inches.
- Lower--round perforation, 1/12 inch.
- Lower--slotted perforation, 1/12 x ¼ inches.

Soybeans:
- Upper--round perforation, 18/64 to 20/64 inches.
- Lower--slotted perforation, 10/64 to 14/64 x ¾ inches.

The labor involved in operating the machine under average conditions consists of two men in addition to the machine operator. The latter's time is pretty well occupied in supervising the equipment.

The wheat cleaning season extends from the completion of threshing to seeding time. In southern Indiana this is 10 or 11 weeks. In northern Indiana it would be only seven to eight weeks as threshing is later and seeding is earlier. In addition to this there is the cleaning of oats and soybean seed, which comes in the spring before the heavy work starts. While the wheat cleaning season is short in the northern part of the state this is offset by a larger amount of oats seed to be cleaned and treated in that area.

The owning and operating of the portable seed cleaning and treating equipment is well adapted to County Farm Bureau Organizations or to millers, processors, or purchasers of the grain from an area as they are materially interested in improvement of quality.

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In several sections custom operators have purchased units and are operating them to excellent advantage to the area and to themselves as well.

The toll collected ranges from four cents to five cents per bushel for cleaning the seed. The treating charges are from two cents to four cents per bushel additional where the operator furnishes the disinfectant dust. Indications from five years experience with this equipment show that the owner and operator gets a fair return at these rates providing he gets volume enough during the year. Machines operating in southern Indiana indicate that a unit can average 20,000 bushels of wheat seed in the 10 weeks period between harvesting and threshing.

A carefully arranged schedule is very essential to avoid loss of time and excessive mileage on the truck. A definite, publicized schedule where the townships or communities are taken in order accomplishes this end.

Experience shows that the greatest demand for the services of the unit come from those that have used it in the past. The excellent work that the machine does, combined with its convenience, increases the demand for it from year to year. The quality of grain going to market from the sections served by this equipment has improved materially each year since the operation of this service started.

The seed treatment given is the one designed for smuts and other seed-borne diseases. It is not a treatment for weevil, but the moving of the grain and the storing of the seed in a clean place checks the activities of grain-chewing insects.

Cautions:

When treating with copper carbonate, workers should avoid inhaling the dust as too much of it is sickening. When using the mercury compounds (New Improved Ceresan) operators should avoid bringing this dust in contact with the skin when wet with perspiration or water as it will cause blistering.

Further information regarding portable seed cleaning and treating equipment and its operation may be had by writing to the Agronomy Department of the Purdue Agricultural Experiment Station at Lafayette, Indiana.

"Ceresan" is a trade name registered in the U. S. Patent Office by the Bayer-Semesan Company, Wilmington, Delaware.

METHYL CHLORIDE SHOWN TO BE A PRACTICAL REFRIGERANT WHEN MEASURED BY THE ACCEPTED THEORETICAL STANDARD

EDITOR'S NOTE:- This concludes a summary of a paper on methyl chloride as a refrigerant. The summary was begun in the August issue of this publication. Mr. McGovern presented the paper at the 42nd Spring Meeting of the American Society of Refrigerating Engineers, French Lick, Indiana, June 10, 1937. Copies of the complete paper may be obtained on request to the editor.

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This is a continuation of the discussion of the properties of the "ideal" refrigerant, as listed in the August issue of this publication.

15. Pressure Differential between High and Low Side-Ratio of Compression: The difference between high and low side pressures of a refrigerant under a given set of conditions should preferably be low. The lower the pressure difference or the lower the pressure ratio of compression (ratio of high side to low side absolute pressure), the lower the capacity loss due to re-expansion of clearance volume gas in cylinder, the lower the throttling losses, the lower the slippage of gas past the piston from high to low side and the easier it is to control operation of liquid valve between high and low sides. Superheat power loss also depends upon ratio of compression, increasing as the ratio increases.

Methyl chloride shows satisfactory low pressure differences. Pressure difference values for various refrigerants, follow very closely the order of their vapor pressures at a given temperature.

16. Superheating of Liquid: Superheating of refrigerant or of refrigerant-oil mixtures in evaporators so that refrigerant does not boil off is, of course, undesirable. Superheating may occur with all refrigerants, particularly in the presence of oil, and logged evaporators are the result. Provision must be made to avoid oil accumulation and ebullition aids may be needed.

17. Lubricating Properties of Refrigerant: An ideal refrigerant would itself possess high lubricating value, since lubricating value in a refrigerant is valuable if oils are seriously diluted by refrigerant. Of the common refrigerants, only sulfur dioxide is claimed to possess any important degree of lubricating value.

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18. Reaction with Lubricant: A refrigerant should show no harmful reaction with lubricant even in the presence of water.

There is no known reaction between methyl chloride and mineral oils or glycerine. There may be reaction of sulfur dioxide at high (tropical) temperatures with oils satisfactory at ordinary temperatures.

19. Solubility of Refrigerant in Lubricant: A refrigerant absolutely insoluble in lubricant would possess some advantages as follows:

a. No oil foaming.
b. Positive means for return of oil from flooded evaporators.
c. Good high side float valve control (refrigerant density constant).
d. Boiling point of refrigerant not raised.

Soluble refrigerants also have advantages:

a. Good carry of oil to moving parts ordinarily difficult to reach.
b. Good carry of oil through dry expansion evaporators.
c. Simplified construction for return of oil from flooded evaporators.
d. No problem of oil separation and return in liquid receivers, and high side float chambers.
e. Good heat transfer through evaporator and condensing surfaces due to minimizing insulating film of oil.
f. Lowering of pour point of oil.

Disadvantages of oil soluble refrigerants can be eliminated or minimized by proper machine construction and also by selection of a refrigerant which, while completely miscible with oil at refrigerant saturation pressures and temperatures, exhibits low solubility of gas in oil under crankcase pressures and temperatures.

The percent by weight of methyl chloride gas which dissolves in oil at the usually encountered temperatures and pressures is not excessive--for example about 16% at 80°F., 40 lb. per sq. inch gage pressure. Boiling point rise caused by oil in evaporators is very low.

Other refrigerants showing complete miscibility with oil include all hydrocarbons and halogenated hydrocarbons.

Carbon dioxide, ammonia, and sulfur dioxide show limited miscibility with oil. However, they dissolve to some extent and, therefore, present to some degree many of the effects of miscible refrigerants.

20. Solubility of Ice: The ideal refrigerant with moisture present, would not precipitate ice when cooled since interruption of refrigeration or faulty operation occurs when ice lodges in expansion valves, evaporators and tubing. Actually, however, due to other objections to the presence of water, especially

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corrosive effects, separation of ice is an advantage in giving warning of presence of water before greater damage results.

Extremely small percentages of water do not freeze out and cause trouble in methyl chloride machines as the solubility is about 0.026% by weight at -11.6°F. and about 0.25% at 32°F.

21. Life and Health Hazard-Toxicity: The theoretical ideal refrigerant would not be a potential danger to life or health under any conditions. It would not in itself be toxic or asphyxiating in any concentration, it would not form toxic or asphyxiating decomposition or combustion products, it would not operate under or build up high pressures so as to tend to escape confinement with explosive force, it would be non-irritant so as to present no panic hazard in case of leakage and would present no fire or explosion hazard.

There is no substance known which meets all of these requirements perfectly although air and even more so water come very close to it. Air and water are eliminated from widespread use as refrigerants in spite of their high possibilities from a safety standpoint because engineering disadvantages would make their use expensive and would present, in some cases, problems extremely difficult or impossible to solve. Thus, for engineering reasons, a compromise must be made with safety; other refrigerants must be used in ways that will provide a reasonable degree of safety.

Higher concentrations of methyl chloride present serious hazards to life and health but by proper application and by placing proper limitations on quantities used, the life and health hazard of this refrigerant is reduced so as to be extremely low or eliminated. U. S. Public Health Bulletin No. 185 reports death or serious injury to guinea pigs on exposure to 15-30% by volume methyl chloride for a very short time. Underwriters Laboratories Report MH 2375 lists 2.0-2.5% for 2 hr. as causing death or serious injury. Methyl chloride is non-irritant and its use would entail no panic hazard.

Quite a few refrigerants, notably carbon dioxide, methylene chloride and the Freon group, are superior to methyl chloride from the standpoint of toxicity. Ammonia and sulfur dioxide are considerably more toxic than methyl chloride although their irritant nature provides physiological warning of their presence and, at least in most applications, makes them less hazardous than if they were non-irritant. An irritant, acrolein, is sometimes added to methyl chloride, to provide warning power.

Direct comparison of refrigerants according to their toxicities is difficult because of the many factors making up their potential hazards from a health standpoint. One of the most important factors is percentage by volume of the gaseous refrigerant in air required to cause death or serious injury in a given time. Another very important factor is boiling point of the refrigerant. A refrigerant with a boiling point considerably above room temperature is incapable of building up very high concentrations unless heated. The lower the boiling point the higher the vapor pressure of such refrigerants and the higher the

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concentrations that may be built up. High pressure (low boiling) refrigerants escape faster. Escaping tendency aside from the pressure factor is of some importance although minor. Density and diffusion rate of a gas determine to some extent the tendency of the gas to concentrate near floor levels rather than to be diluted by even diffusion throughout a room.

Underwriters Laboratories Report MH 1418 states "density (about twice that of air) and relative rate of diffusion of Methyl Chloride less than that of air) are considered not to contribute particularly to the hazard." This statement is made in speaking of fire hazard but the same should apply to health hazard.

Physiological warning of presence through irritant effects or odor lowers to some degree the hazard presented by a refrigerant, although for certain types of installations, such as in places of public assembly, this may introduce a panic hazard. Some gases of relatively low toxicity form irritant and toxic decomposition products when exposed to flames or hot surfaces; this is true to a greater or less degree of all chlorinated and/or fluorinated hydrocarbons.

22. Fire and Explosion Hazard: A refrigerant should present no fire or explosion hazard. In this discussion the term "fire hazard" is not taken to include the subject of poisonous decomposition products. Methyl chloride is classed by Underwriters Laboratories Report MH 1418 as moderately flammable with a moderate explosion hazard. Approximately 10 lb. per 1000 cubic ft. of air are required to give a concentration of 8.1% by volume, the lower explosive limit; mixtures containing less than 8.1% will not explode. The upper explosive limit is 17.2%. These figures show that explosion hazard is taken care of when proper limitations from a toxicity standpoint are placed on the use of methyl chloride; concentrations required to form explosive mixtures are well above the particularly dangerous toxic concentrations.

23. Odor-Irritant Effect: A refrigerant, viewed only from the standpoint of panic hazard, convenience in servicing, and comfort of others who may be exposed to the gas should be non-irritant and odorless, or should at the most have a pleasant but non-lingering odor. If a refrigerant presents hazards or if warning of leakage is desirable, an irritant effect or strong odor may be desirable.

Methyl chloride is non-irritant and has only a faintly sweet odor. 1% acrolein is sometimes added as a warning agent and the mixture is then highly irritant, about 0.1% by volume of the mixture irritating the mucous membranes of the eyes and nose.

24. Effect on Foods, Furs, Flowers, Textiles, Etc.: Refrigerants should not physically harm or poison substances with which they may come in contact in case of escape of the gas.

Tests have shown that methyl chloride vapors do not harm furs, flowers, textile and other household articles. Experiments described in Public Health Reports, Vol. 45, No. 19 indicates that there is no particular danger in eating foods or drinking beverages that have been exposed to methyl chloride vapors.

25. Leakage Tendency: The ideal refrigerant, for reasons of economy, uninterrupted operation and safety, would show low escaping tendency. Rate of leakage

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depends upon refrigerant properties of pressure difference, viscosity and density, as well as diffusion factors including molecular weight. Diffusion through oil film on seal surfaces may be important especially where solubility of refrigerant in oil is high and where pressure of refrigerant on seal is greater than atmospheric.

Experimental data on leakage tendencies of various refrigerants under operating conditions are not available. Actual experience has shown methyl chloride to have a relatively low leakage tendency when compared to other refrigerants operating at positive low side pressures. Modern seals, replacing the old stuffing boxes, have satisfactorily solved the seal problem with methyl chloride.

26. Detection and Location of Leaks: Methyl chloride leaks are not as easy to locate as are leaks of some other refrigerants. No satisfactory fog test such as is used with ammonia and sulfur dioxide is available. Leaks of methyl chloride are best detected and located by placing the unit under refrigerant, air or nitrogen pressure and applying soap solution to suspected points. Oil spots also enable detection and location of leaks as methyl chloride in all parts of the system carries more or less oil.

27. Physiological Warning of Leakage: Physiological warning of presence of refrigerant is desirable if only from the standpoints of economy and uninterrupted operation. To give adequate and sure warning of leakage, a refrigerant should be irritant rather than merely odorous.

It will be noted that we here have two desirable qualities which are opposed to each other--on one hand we have the advantages of no odor and on the other we have the advantages of warning power.

28. Cost. Of the commoner refrigerants mentioned in this paper, sulfur dioxide, ammonia and carbon dioxide cost less per pound than methyl chloride. The low density of liquid methyl chloride improves its standing from the standpoint of cost of refrigerant charge for a given installation as compared to denser refrigerants.

Field of Application--Methyl Chloride

From the foregoing discussion of refrigerant properties and requirements, it may be noted that methyl chloride has many excellent qualities and many of an intermediate position as compared to other refrigerants but no excessively bad ones.

In particular it is strong in the points required of refrigerants for use in small systems of up to at least ten tons capacity but its qualities of intermediate relative value satisfactorily meet the requirements of small systems of most types and applications. For these reasons methyl chloride is generally accepted as the best of available refrigerants for "commercial" compressors with the possible exception of a few types of systems. It also finds considerable use as a refrigerant for household refrigerators and is well suited for this purpose.

Competitive refrigerants in the household field, used in rotary compressors, include F-114, F-21, sulfur dioxide and methylene chloride. Certain advantages of

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rotary compressors are the main factor here, rather than advantages of the refrigerants over methyl chloride in addition to their better adaptability to small rotary compressors. Sulfur dioxide has found considerable use in reciprocating household refrigerator compressors, its main advantage over methyl chloride here being simplicity of the oil-high side float problem when this type of system is used. Freon-12 is finding increased use in the household field as developments proceed to allow use of this newer refrigerant efficiently and economically.

For large industrial systems, ammonia is preferable to methyl chloride, mainly, because of low volume displacement, low volume of liquid circulated and higher efficiency in large systems. Methyl chloride is preferable to ammonia for smaller systems, mainly, because low volumes of liquid ammonia circulated (accurate control difficult), higher pressures of ammonia and restrictions on use of copper and brass with ammonia.

In the air conditioning field, when refrigerant charges are large, toxicity and fire hazard are of major importance. The Freon group of refrigerants, especially Freon-12 in reciprocating compressors and Freon-11 in centrifugal compressors, are, therefore, of major importance here. Methylene chloride in centrifugal compressors and to some extent carbon dioxide are also used because of low toxicity and absence of fire hazard.

A DOUBLE BARRELED PLAN OF WATERFOWL RESTORATION TO INCLUDE MAKING AVAILABLE DRAINED WATER AREAS

EDITOR'S NOTE:- This is a discussion of the plight of waterfowls and the steps necessary to restore proper conditions for their continued existence and increase. What this authority on the subject points out should be of particular interest to agricultural engineers, since they are usually consulted before drainage projects are undertaken on a great deal of private land.

By Ira N. Gabrielson, Chief,
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The waterfowl resources of this continent have been and still are in a precarious condition. We have long pursued a continent-wide policy of destruction of lakes and marshes which, together with a constantly increasing number of shooters, has created a situation that can be met only by drastic and positive action.

The waterfowl restoration program is based on two simple biological truths. First, we must have marshes and waters on which waterfowl may breed, feed, and rest. Second, we must have breeding stocks of birds to use these marshes. We must have both--either without the other is useless. In this simple statement is the entire philosophy of the waterfowl program now under way.

The plain facts are that advancing agriculture and drainage projects have pushed the waterfowl breeding areas constantly northward. The effect of this has been accentuated by drouth in the past few years. During this period of a constantly decreasing water area, a growing body of hunters has been taking an increasing toll of the birds, all the while lulled into a false sense of security by the fact that there were still heavy flights of birds concentrating in season on the remaining water areas. It should be apparent to anyone that if the water area available be cut in half it will require only half as many birds to produce as heavy a concentration as ever on the remaining waters. Any duck hunter should understand this, but try to convince some of them even yet.

This coincidental shrinking of waterfowl and water areas has obscured the problem and perhaps delayed necessary action. If we still had all the former marsh areas available and only the present stocks of waterfowl to populate them the true picture would be much clearer.

Now what can be, or is being, done about it? Many, but not all, of the drained marshes and lakes can be restored, and the time is propitious, for never before has America been so conscious of the value of both wildlife and water.

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Those drained lands that have been developed into good farm lands must be forgotten, but there are still enough drainage failures and near failures on which we can use our resources and energy for may years.

Federal and State Agencies Active

The Biological Survey has a definite restoration program under way, and an increasing number of States are also engaged in the same work. The action arises from a variety of needs, among which flood control, restoration of water levels, recreation, and providing for wildlife loom large. These restorations involve purchase of lands; building of dams, dikes, or ditches; construction of fences and buildings; planting of trees, shrubs, and aquatic plants; and a host of related activities. Not only is it necessary to reflood the land but to insure as nearly as may be possible a constant water supply. Nearly two million acres have been purchased, and public lands, reclamation reservoirs, and other public areas available have brought the total new refuge areas well toward our halfway mark in reaching the minimum of 7,500,000 acres necessary to lay out the primary refuge system.

Any 7,500,000 acres will not do. The areas must be distributed at strategic points in the breeding grounds, along the main flyways, and on wintering grounds if habitat restoration is to furnish effectively the food and security needed by the breeding stocks of birds to maintain the flights. About one-half the needed areas are either partially or entirely under control, and on many of these construction is well along. In other words, land acquisition is reaching the halfway mark although there are seventy-odd gaps in the system yet needing to be filled before we can realize its full value. Construction is necessarily somewhat behind, as it cannot get under way until the land is acquired.

The other half of the job, that of seeing that adequate breeding stocks return each year, is a responsibility not only of wildlife administrative officials but also of every sportsman interested in wildfowling. All of the work in restoring marsh lands will be in vain if there are no ducks to populate them.

The facts are that even now there are available breeding grounds in Canada and Alaska that are not utilized nearly to capacity. The testimonies of our biologists, those of the Canadian Government, and of independent observers are alike on this point. The breeding ground restoration in our own northern States will care for more breeding birds each year for several years to come. Therefore we must send back an increasing number of birds each year for a number of years.

Only One Practical Plan

How are we going to do it? There is only one answer, and it is not an easy one. We must limit the total loss of birds from all causes to something less than the annual production. The greater the saving, the quicker the restoration. Birds are lost from a great variety of causes. Under present conditions the greatest, and incidentally the only controllable, one is hunting. Great storms, sudden severe freezes, disease, and natural enemies all take their toll from the time the egg is laid. The effects of some of these can be modified by continued efforts, but the human take is the only one that can be effectively reduced quickly.

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For two years now drastic restrictions have reduced the legal kill of birds far below that of any previous years. It will still be necessary to hold down the take for several years to come--the length of time depending to some extent on the effectiveness of the regulations in accomplishing their purpose. This effectiveness depends largely on the cooperation of the sportsmen. If any considerable numbers of them cheat, they are succeeding only in delaying the time when less burdensome restrictions might become a possibility.

For those who long for the good old days when a hunter--sportsman or otherwise--counted his annual kill in hundreds if not thousands of birds, this program promises little. I cannot foresee the time when there will again be enough birds to permit such practices for even a much smaller number of hunters than are now in the field, and of course the number of hunters may still increase. For the man who gets his enjoyment in the company of his hunting companions, in the evening sessions around the fire, and the sights and sounds of the marsh lands there is the possibility of a moderate amount of satisfying sport for a long time to come.

This possibility may become a reality if support enough is given this double-barreled program of waterfowl restoration by providing habitat and restricting hunting.

MUD-CAP BLASTING OF FIELD BOULDERS WITH DYNAMITE WHEN TEMPERATURE IS LOW SEEN TO OFFER ADVANTAGES

EDITOR'S NOTE:- Mr. Livingston explains that he does not vouch for the theory discussed here. He would, he said, be interested to learn of any scientific investigational work that may have been done in this connection. Explosives technical men have long known that very cold rock shatters better than rock at elevated temperatures.

By L. F. Livingston, Manager,
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In the colder sections of the country very little use of dynamite for land improvement is made during the winter months. There is, of course, reason for this lack of blasting in the cases of stump removal and ditch blasting. But field boulders can be successfully blasted regardless of temperature, since soil conditions need not be taken into consideration. Reference here is to boulders which are almost entirely on the surface of the ground. In other words, boulders which ordinarily would be mud-capped. It is not recommended that snake-hole blasting be attempted when ground is hard frozen, because of the difficulty of removing the soil to permit loading.

The experience of expert blasters shows that rock can be broken up with dynamite more readily when the temperature is well below freezing for several days than during warm weather. To the writer's knowledge, why this is so has never been demonstrated scientifically.

However, the theory is advanced that when very cold, rock is subjected to internal pressure, due to the freezing of the moisture it contains, it is believed that, while the strain is not sufficient to completely disrupt rock, it assists materially the shattering effect of an explosion of dynamite.

Effect Varies With Kinds of Rock

Assuming the stated theory to be correct, it is at once evident that soft limestone, when its water content is frozen, is disproportionately easier to blast than hard granite. This, by reason of the fact that limestone, because of its greater porosity, absorbs more water, the freezing of which creates greater total pressure than the relatively small quantity of water absorbed by granite. The greater toughness of granite, of course, combines with its lower water-absorption capacity to make it more difficult to blast.

Theories are always interesting. More than that, workable theories are essential to achieving worthwhile things in all branches of science, whether in

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the field of "pure" science or in "applied" research, as in the development of industrial chemical products. But the greater concern of those who serve agriculture is how to accomplish things in a practical way. Therefore, this article was prepared to bring to the attention of all who are in contact with farmers information about the advantage of doing mud-cap boulder blasting in winter. The theory that the freezing of water in a rock is a blasting "assistant" is presented as a thing of interest.

How to Mud-cap Without Mud

The procedure for "loading" a mud-cap blast is known to all who are at all familiar with agricultural uses of dynamite. But there could be raised the question of how to "cap" a charge of dynamite when mud is not available. It is to answer that wet sawdust, wet bran or any other wet material may be used. The sole purpose of the cap is to confine as much as possible the force of the explosion so that it will exert a hammer-blow effect on the rock. What to use is not important. The thing to make sure of is that the material is wet and of the consistency of firm mud, and that a sufficient quantity is used.

It would seem of importance that farmers be acquainted with the advantages of blasting boulders during the cold months. This is suggested not only because of the greater effectiveness of rock blasts in winter but also for the reason that many farmers have more time to devote to land improvement than at any other period of the year.

A rock pile can come in handy for many purposes on almost any farm, not the least of the uses of stone can be for foundations for driveways, lanes and the like.

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